

TITLE OF THE INVENTION

**FILE MANAGEMENT APPARATUS**

This application is based on an application  
5 No.2000-138642 filed in Japan, the content of which is hereby  
incorporated by reference.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

10 The present invention relates to a file management  
apparatus that encrypts and stores information, to prevent  
third parties from knowing its contents.

(2) Related Art

15 With the widespread use of computers, techniques for  
storing information after encrypting the information have  
been generally employed to prevent third parties from knowing  
the contents of the information.

Japanese Laid-Open Patent Application No. H9-204330  
discloses a technique for encrypting a file in a computer  
20 using an encryption key and storing the encrypted file in  
a specific encrypted information storage area, to allow only  
specific users to have access to the encrypted information  
storage area with registered authentication passwords. Each  
specific user memorizes an authentication password. When the  
25 user inputs the authentication password, a decryption key

is automatically selected so as to decrypt the encrypted file.  
Here, the authentication password may be composed of a  
character string or a number that is short enough for a person  
to memorize, and the encryption key and the decryption key  
5 have more bits than the authentication password.

According to the above technique, however, the  
difficulty still lies in that the user has to memorize the  
authentication password. In case the user forgets the  
authentication password, he or she cannot decrypt the  
10 encrypted file

#### SUMMARY OF THE INVENTION

In view of the above problem, the object of the present  
invention is to provide a file management apparatus that is  
15 capable of managing encrypted information securely, and that  
ensures decryption of the encrypted information even when  
the user forgets a password.

The above object can be achieved by a file management  
apparatus that encrypts a plaintext to generate a ciphertext,  
20 stores the ciphertext, and decrypts the ciphertext, the file  
management apparatus including: a key storage medium storing  
key information beforehand; a registration unit for  
encrypting the key information using a password to generate  
an encrypted key; an encryption unit for encrypting a plaintext  
25 based on the key information to generate a ciphertext; a switch  
unit for switching between (a) generating key information

by decrypting the encrypted key using the password and (b) reading the key information from the key storage medium; and a decryption unit for decrypting the ciphertext based on one of the generated key information and the read key information.

5 The file management apparatus may further include a memory unit, wherein the registration unit receives an input of the password, encrypts the key information using the received password to generate the encrypted key, and writes the generated encrypted key to the memory unit, the encryption  
10 unit encrypts the plaintext using a file key to generate the ciphertext, encrypts the file key using the key information to generate an encrypted file key, and writes the ciphertext in association with the encrypted file key, to the memory unit, the switch unit (a) includes a first key obtaining unit  
15 for receiving an input of the password and decrypting the encrypted key using the received password to generate the key information, and a second key obtaining unit for reading the key information from the key storage medium, and (b) obtains the key information by one of the first key obtaining unit  
20 and the second key obtaining unit, and the decryption unit decrypts the encrypted file key using the obtained key information to generate a file key, and decrypts the ciphertext using the file key to generate a decrypted text.

According to this construction, operations are switched  
25 between (a) generating key information by decrypting the

encrypted key using the password and (b) reading key  
information from the key storage medium, and the ciphertext  
is decrypted based on the generated key information or the  
read key information. Therefore, the ciphertext can be  
5 decrypted without a password.

The above object can also be achieved by a file management  
apparatus that encrypts a plaintext to generate a ciphertext,  
stores the ciphertext, and decrypts the ciphertext, the file  
management apparatus including: a key storage medium storing  
10 key information beforehand; a registration unit for encrypting  
a password using the key information to generate an encrypted  
password; an encryption unit for encrypting a plaintext using  
a file key to generate a ciphertext, encrypting the file key  
based on a password obtained by decrypting the encrypted  
15 password to generate a first encrypted file key, and encrypting  
the file key based on the key information to generate a second  
encrypted file key; a switch unit for switching between (a)  
decrypting the first encrypted file key based on the password  
and (b) decrypting the second encrypted file key based on  
20 the key information, to generate a file key; and a decryption  
unit for decrypting the ciphertext using the generated file  
key.

The file management apparatus may further include a memory  
unit, wherein the registration unit receives an input of the  
25 password, encrypts the received password using the key

information to generate the encrypted password, and writes  
the generated encrypted password to the memory unit, the  
encryption unit decrypts the encrypted password using the  
key information to generate the password, encrypts the  
5 plaintext using the file key to generate the ciphertext,  
encrypts the file key using the password to generate the first  
encrypted file key, encrypts the file key using the key  
information to generate the second encrypted file key, and  
writes the ciphertext in association with the first encrypted  
10 file key and the second encrypted file key, to the memory  
unit, the switch unit (a) includes a first key obtaining unit  
for receiving an input of the password and decrypting the  
first encrypted file key using the received password, and a  
second key obtaining unit for decrypting the second encrypted  
15 file key using the key information, and (b) obtains the file  
key by one of the first key obtaining unit and the second  
key obtaining unit, and the decryption unit decrypts the  
ciphertext using the obtained file key to generate a decrypted  
text.

20 According to this construction, operations are switched  
between (a) decrypting the encrypted file key based on the  
password and (b) decrypting an encrypted file key based on  
the key information, to generate a file key, and the ciphertext  
is decrypted based on the file key. Therefore, the ciphertext  
25 can be decrypted without a password.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, advantages and features of the invention will become apparent from the following description thereof taken in conjunction with the accompanying drawings that illustrate a specific embodiment of the invention. In the drawings:

Fig. 1 shows an appearance of a file management apparatus relating to a first embodiment of the present invention;

10 Fig. 2 is a block diagram showing a construction of the file management apparatus;

Fig. 3 is a flowchart showing an operation of a password registration unit in the first embodiment;

15 Fig. 4 is a flowchart showing an operation of a file encryption unit in the first embodiment;

Fig. 5 is a flowchart showing an operation of a file decryption unit in the first embodiment;

Fig. 6 shows an example of a user ID table;

20 Fig. 7 is a flowchart showing an operation of the file management apparatus when a password is changed;

Fig. 8 is a flowchart showing an operation of the file management apparatus when key information is changed;

Fig. 9 shows an example of data structure of an encrypted file in the first embodiment;

25 Fig. 10 is a block diagram showing a construction of

a file apparatus relating to a second embodiment of the present invention;

Fig. 11 is a flowchart showing an operation of a password registration unit in the second embodiment;

5 Fig. 12 is a flowchart showing an operation of a file encryption unit in the second embodiment;

Fig. 13 is a flowchart showing an operation of a file decryption unit in the second embodiment;

10 Fig. 14 is a flowchart showing an operation of the file management apparatus when a password is changed;

Fig. 15 is a flowchart showing an operation of the file management apparatus when key information is changed;

15 Fig. 16 is a flowchart showing an operation when a key storage medium is lost in the second embodiment. To be continued to Fig. 17;

Fig. 17 is a flowchart showing the operation when the key storage medium is lost in the second embodiment. To be continued to Fig. 18; and

20 Fig. 18 is a flowchart showing the operation when the key storage medium is lost in the second embodiment. Continued from Fig. 17.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 The following is an explanation of preferred embodiments of the present invention, with reference to the drawings.

## 1. First Embodiment

The following is an explanation of a file management apparatus 10 relating to a first embodiment of the present invention.

5 Fig. 1 shows an appearance of the file management apparatus 10. As shown in the figure, the file management apparatus 10 is a computer system that is roughly composed of a microprocessor, a ROM, a RAM, a hard disc unit, a display unit, and a keyboard. The RAM or the hard disc unit stores  
10 a computer program. The functions of the file management apparatus 10 are realized by the microprocessor operating according to the computer program. A key storage medium 20 which stores key information beforehand is equipped in the file management apparatus 10.

### 15 1.1 Constructions of the File Management Apparatus 10 and the Key Storage Medium 20

The following is an explanation of the constructions of the file management apparatus 10 and the key storage medium 20.

20 As shown in Fig. 2, the file management apparatus 10 includes a password registration unit 100, a file encryption unit 200, a file decryption unit 300, and a storage unit 400, and the key storage medium 20 is connected to the file management apparatus 10.

25 The password registration unit 100 includes a password

input unit 101 and an encryption unit 102. The file encryption unit 200 includes a file key generation unit 201, an encryption unit 202, and an encryption unit 203. The file decryption unit 300 includes a password input unit 301, a decryption unit 302, a switch unit 303, a decryption unit 304, and a decryption unit 305.

#### (1) Key Storage Medium 20

The key storage medium 20 is a portable storage medium having a storage area made up of a nonvolatile semiconductor memory. The storage area stores 56-bit key information beforehand.

The key information is unique to a user, and the user usually possesses the key storage medium 20. To operate the file management apparatus 10, the user inserts the key storage medium 20 in a special drive equipped with the file management apparatus 10, to connect the key storage medium 20 to the file management apparatus 10.

#### (2) Storage Unit 400

The storage unit 400 is constructed of a hard disc unit, and is internally equipped with a storage area for storing information as files. Each file is identified by a file name.

The storage unit 400 stores a plaintext file 401 beforehand, the plaintext 401 storing a plaintext.

#### (3) Password Input Unit 101

The password input unit 101 receives an input of a

password from the user. Here, the password is a string of eight characters composed of numerals and alphabets. The password input unit 101 outputs the received password to the encryption unit 102.

5 (4) Encryption Unit 102

The encryption unit 102 receives the password from the password input unit 101. On receipt of the password, the encryption unit 102 reads the key information from the storage area of the key storage medium 20, adds a plurality of zero  
10 bits to the end of the password to make it 56 bits long, and adds a plurality of zero bits to the end of the key information to make the key information 64 bits long. Following this, the encryption unit 102 subjects the key information to the encryption algorithm E1 using the password as a key to generate  
15 an encrypted key. Here, the encryption algorithm E1 complies with Data Encryption Standard (DES). Note that DES is well-known, and so it is not explained here.

In a block diagram in Fig. 2, a key mark near a line connecting the password input unit 101 and the encryption  
20 unit 102 indicates that the encryption unit 102 uses the password outputted from the password input unit 101 as a key. The same applies to other encryption and decryption units in Fig. 2, and to encryption and decryption units in Fig.  
10.

25 The encryption unit 102 then writes the generated

encrypted key as a file to the storage unit 400.

#### (5) File Key Generation Unit 201

The file key generation unit 201 is internally equipped with a random number generation unit and a timer, and so  
5 generates a 56-bit random number, acquires the current time expressed by year, month, day, hour, minute, second, and millisecond, takes an exclusive-OR of the generated random number and the acquired current time so as to generate a file  
10 to the encryption unit 202 and the encryption unit 203.

#### (6) Encryption Unit 203

The encryption unit 203 receives the user designation of a file name of the plaintext file 401 stored in the storage unit 400, and reads the plaintext file 401 identified by the  
15 file name from the storage unit 400. Also, the encryption unit 203 receives the file key from the file key generation unit 201.

The encryption unit 203 then subjects a plaintext included in the plaintext file 401 to the encryption algorithm  
20 E3 using the received file key as a key, to generate a ciphertext. The encryption unit 203 then writes an encrypted file 404 to the storage unit 400. The encrypted file 404 is composed of a header part, and a data part that includes the generated ciphertext. It should be noted here that the encryption  
25 algorithm E3 complies with DES.

Here, when the plaintext is at least 64 bits long, the encryption unit 203 divides the plaintext into a plurality of plaintext blocks, each plaintext block being 64 bits long. The encryption unit 203 then subjects each plaintext block  
5 to the encryption algorithm E3 to generate a ciphertext block, and concatenates each generated ciphertext block to form a ciphertext.

#### (7) Encryption Unit 202

The encryption unit 202 reads the key information from  
10 the key storage medium 20, receives the file key from the file key generation unit 201, and adds a plurality of zero bits to the end of the file key so as to make the file key 64 bits long.

The encryption unit 202 then subjects the file key to  
15 the encryption algorithm E2 using the read key information as a key to generate an encrypted file key, and writes the generated encrypted file key into the header part of the encrypted file 404 in the storage unit 400. It should be noted here that the encryption algorithm E2 complies with DES.

#### 20 (8) Switch Unit 303

The switch unit 303 receives an input of either a first type or a second type from the user. The first type indicates to decrypt a ciphertext using a password, and the second type indicates to decrypt a ciphertext using key information.

25 When the input of the first type is received, the switch

unit 303 receives the key information from the decryption unit 302, and outputs the received key information to the decryption unit 304. When the input of the second type is received, the switch unit 303 reads the key information from the key storage medium 20, and outputs the read key information to the decryption unit 304.

(9) Password Input Unit 301

The password input unit 301, as the password input unit 101, receives the input of the password from the user and outputs the received password to the decryption unit 302.

(10) Decryption Unit 302

The decryption unit 302 receives the password from the password input unit 301, reads the encrypted key from the storage unit 400, adds a plurality of zero bits to the end of the password so as to make the password 56 bits long, and subjects the read encrypted key to the decryption algorithm D1 using the password as a key to generate key information. It should be noted here that the decryption algorithm D1 complies with DES, and is to perform the inverse conversion to the encryption algorithm E1.

Following this, the decryption unit 302 deletes the bit string of the generated key information except the first 56 bits, and outputs the 56-bit key information to the switch unit 303.

(11) Decryption Unit 304

The decryption unit 304 receives the key information from the switch unit 303, reads the encrypted file key included in the header part of the encrypted file 404 in the storage unit 400, and subjects the read encrypted file key to the decryption algorithm D2 using the received key information as a key to generate a file key. It should be noted here that the decryption algorithm D2 complies with DES, and is to perform the inverse conversion to the encryption algorithm E2.

The decryption unit 304 then deletes the bit string of the generated file key except the first 56 bits, and outputs the 56-bit file key to the decryption unit 305.

#### (12) Decryption Unit 305

The decryption unit 305 receives the file key from the decryption unit 304, reads the ciphertext included in the data part of the encrypted file 404 in the storage unit 400, and subjects the read ciphertext to the decryption algorithm D3 using the received file key as a key to generate a decrypted text. It should be noted here that the decryption algorithm D3 complies with DES, and is to perform the inverse conversion to the encryption algorithm E3.

Here, when the ciphertext is at least 64 bits long, the decryption unit 305 divides the ciphertext into a plurality of ciphertext blocks, each ciphertext block being 64 bits long. The decryption unit 305 then subjects each ciphertext block to the decryption algorithm D3 to generate a decrypted

text block, and concatenates each generated decrypted text block to form a decrypted text.

Following this, the decryption unit 305 writes a decrypted text file 402 including the generated decrypted text to the storage unit 400.

## 1.2 Operation of the File Management Apparatus 10

The following is an explanation of the operation of the file management apparatus 10.

### (1) Operation of the Password Registration Unit 100

The following is an explanation of the operation of the password registration unit 100, with reference to a flowchart shown in Fig. 3.

The password input unit 101 receives an input of a password from the user, and outputs the received password to the encryption unit 102 (step S101).

The encryption unit 102 then reads key information from the storage area of the key storage medium 20 (step S102), subjects the read key information to the encryption algorithm E1 using the password as a key to generate an encrypted key (step S103), and writes the generated encrypted key as a file to the storage unit 400 (step S104).

### (2) Operation of the File Encryption Unit 200

The following is an explanation of the operation of the file encryption unit 200, with reference to a flowchart shown in Fig. 4.

The file key generation unit 201 generates a file key (step S121). Following this, the encryption unit 203 reads the plaintext file 401 from the storage unit 400, subjects a plaintext stored in the plaintext file 401 to the encryption  
5 algorithm E3 using the generated file key as a key to generate a ciphertext (step S122), and writes the encrypted file 404 including the generated ciphertext in the data part thereof, to the storage unit 400 (step S123).

Following this, the encryption unit 202 reads key  
10 information from the key storage medium 20, receives the file key from the file key generation unit 201, subjects the received file key to the encryption algorithm E2 using the read key information as a key to generate an encrypted file key (step S124), and writes the generated encrypted file key into the  
15 header part of the encrypted file 404 in the storage unit 400 (step S125).

### (3) Operation of the File Decryption Unit 300

The following is an explanation of the operation of the file decryption unit 300, with reference to a flowchart shown  
20 in Fig. 5.

The switch unit 303 receives an input of either the first type or the second type from the user (step S141).

When the switch unit 303 receives the input of the first type (step S142), the password input unit 301 receives an  
25 input of a password from the user and outputs the received

password to the decryption unit 302 (step S144). The decryption unit 302 reads an encrypted key from the storage unit 400, subjects the read encrypted key to the decryption algorithm D1 using the password as a key to generate key  
5 information, and outputs the generated key information to the decryption unit 304 via the switch unit 303 (step S145).

When the switch unit 303 receives the input of the second type (step S142), the switch unit 303 reads key information from the key storage medium 20, and outputs the read key  
10 information to the decryption unit 304 (step S143).

Following this, the decryption unit 304 receives the key information from the switch unit 303, reads an encrypted file key included in the header part of the encrypted file 404 in the storage unit 400, and subjects the read encrypted  
15 file key to the decryption algorithm D2 using the received key information as a key to generate a file key (step S146). The decryption unit 305 reads a ciphertext included in the data part of the encrypted file 404 in the storage unit 400, subjects the read ciphertext to the decryption algorithm D3  
20 using the file key as a key to generate a decrypted text (step S147), and writes the decrypted text file 402 including the generated decrypted text, to the storage unit 400 (step S148).

### 1.3 Conclusions

As described above, the file management apparatus 10  
25 has the three functions : password registration; plaintext

encryption; and ciphertext decryption.

For registering a password, the user loads the key storage medium 20 on the file management apparatus 10, and inputs a password to be registered. The password registration unit 5 100 encrypts key information using the input password, and stores the generated encrypted key as a file in the computer.

For encrypting a plaintext, the user loads the key storage medium 20 on the file management apparatus 10, and designates a file to be encrypted. Here, a password does not need to be inputted for encrypting each plaintext, which makes the encryption processing easier for the user. The file encryption unit 200 generates a file key arbitrarily, encrypts the generated file key using the key information to generate an encrypted file key, encrypts information stored in the 10 file using the generated file key to generate a ciphertext, and writes an encrypted file to the storage unit 400, the encrypted file including the encrypted file key in the header part thereof and the ciphertext in the data part thereof.

For decrypting a ciphertext, there are two methods, one 20 using key information and the other using a password. When using key information, the file decryption unit 300 decrypts an encrypted file key obtained from the header part of the encrypted file using the key information, to obtain a file key. The file decryption unit 300 then decrypts a ciphertext 25 using the obtained file key as a key. When using a password,

the file decryption unit 300 receives an input of a password from the user, decrypts an encrypted key using the received password to obtain key information, decrypts an encrypted file key using the key information to obtain a file key, and  
5 finally decrypts a ciphertext using the file key as a key to obtain the plaintext.

According to the above construction of the file management apparatus 10, encrypted information is usually decrypted using key information, and when the user fails to  
10 bring a key storage medium storing key information, encrypted information can be decrypted using a password as described above.

#### 1.4 Modifications

Although the present invention has been described based  
15 on the first embodiment, the invention should not be limited to such. For instance, the file management apparatus 10 may be constructed according to the following modifications.

(1) The password registration unit 100 may further receive an input of a user identifier (user ID) that identifies  
20 the user, and write the encrypted key, in association with the user identifier, into a user ID table in the storage unit 400. Fig. 6 shows an example of the user ID table. The user ID table has an area for storing a plurality of pairs each composed of an user ID and an encrypted key. In this case,  
25 the file decryption unit 300 receives an input of a user ID,

and then decrypts an encrypted key that is associated with the input user ID in the user ID table.

With this construction, a plurality of users can use the file management apparatus 10.

5       (2) The following is an explanation of the operation of the file management apparatus 10 when a password is changed, with reference to a flowchart shown in Fig. 7.

The file management apparatus 10 further includes a deletion unit for deleting the encrypted key stored in the  
10 storage unit 400 (step S161).

The password input unit 101 in the password registration unit 100 receives an input of a new password from the user, and outputs the received new password to the encryption unit 102 (step S162). The encryption unit 102 then reads key  
15 information from the storage area of the key storage medium 20 (step S163), subjects the read key information to the encryption algorithm E1 using the new password as a key, to obtain a new encrypted key (step S164), and writes the generated new encrypted key as a file to the storage unit 400 (step  
20 S165).

In the above described way, a new encrypted key is generated when the password is changed.

(3) For preventing encrypted information from being decrypted using a password, the only thing to do is to delete  
25 the encrypted key that has been encrypted using the password.

(4) The following is an explanation of the operation of the file management apparatus 10 when key information is updated, with reference to a flowchart shown in Fig. 8.

The key storage medium 20 stores new key information beforehand, instead of the key information employed previously (referred to as old key information).

The password input unit 101 receives an input of a password that is the same as the password received previously (step S181). The encryption unit 102 subjects the encrypted key (hereafter referred to as the old encrypted key) to the decryption algorithm D1 using the received password as a key to generate key information that is the same as the old key information (step S182), reads the new key information from the key storage medium 20, subjects the read new key information to the encryption algorithm E1 using the password as a key to generate a new encrypted key (step S183), and updates the old encrypted key stored in the storage unit 400 to the generated new encrypted key (step S184).

The file encryption unit 200 then reads the encrypted file key generated previously (hereafter referred to as the old encrypted file key) from the storage unit 400, and subjects the old encrypted file key to the decryption algorithm D2 using the old key information as a key, to generate a file key (step S185), reads the new key information from the key storage medium 20, subjects the file key to the encryption

algorithm E2 using the new key information as a key to generate a new encrypted file key (step S186), and updates the old encrypted file key in the encrypted file to the new encrypted file key (step S187).

5           In this way, for updating key information, the key information before being updated is first obtained using the old encrypted key and the password. An encrypted file key included in the header is then decrypted using the old key information to obtain a file key. Following this, the file  
10 key is encrypted using the new key information, and the encrypted file key is updated. Here, the encrypted key is updated, too.

          Note in the present embodiment, when key information is lost, the key information cannot be made temporarily  
15 invalid.

          (5) When encrypting a plaintext, the file encryption unit 200 may add encryption information to the header part of the encrypted file, the encryption information indicating that the plaintext has been encrypted. In this case, when  
20 key information is updated, the file encryption unit 200 may retrieve the encrypted file key in the encrypted file 404 to whose header the encryption information has been added, and generate a file key from the retrieved encrypted file key.

25           Also, the password registration unit 100 may receive

an input of a user ID that identifies the user, and the file encryption unit 200 may additionally write the user ID to the encrypted file that includes the ciphertext and the encrypted file key. In this case, when key information is  
5 updated, the file encryption unit 200 may retrieve the encrypted file key in the encrypted file to which the user ID has been added, and generate a file key from the retrieved encrypted file key.

Also, the file encryption unit 200 may write the user  
10 ID and a file identifier that identifies the encrypted file including the ciphertext and the encrypted file key, in association with each other, as a unified file, to the storage unit 400. In this case, the file encryption unit 200 may extract the file identifier that is associated with the user  
15 ID from the unified file, identify the encrypted file key included in the file identified by the extracted file identifier, and generate a file key from the identified encrypted file key.

Alternatively, the file encryption unit 200 may write  
20 (a) encryption information indicating that the plaintext has been encrypted and (b) a file identifier that identifies the encrypted file including the ciphertext and the encrypted file key, in association with each other, as a unified file, to the storage unit 400. In this case, the file encryption  
25 unit 200 may extract the file identifier that is associated

with the encryption information from the unified file,  
identify the encrypted file key included in the file identified  
by the extracted file identifier, and generate a file key  
from the identified encrypted file key.

5           (6) In the above embodiment, the encrypted key is stored  
in one computer system, and so decryption of a ciphertext  
using a password is made only possible within the computer  
system. To enable the decryption of the ciphertext using the  
password in another computer system, the encrypted key may  
10 be stored in a portable storage medium, and may be inputted  
into the other computer system.

Here, the password registration unit 100 in the computer  
system writes the encrypted key to a portable storage medium  
such as a SD memory card. Also, the user writes the encrypted  
15 file to another portable storage medium. The user then loads  
the portable storage medium to which the encrypted key has  
been written, and the portable storage medium to which the  
encrypted file has been written, on the other computer system,  
so that a file decryption unit in the other computer system  
20 reads the encrypted key from the portable storage medium,  
decrypts the read encrypted key, and also, reads the encrypted  
file from the portable storage medium, and decrypts the read  
encrypted file.

It should be noted here that the encrypted key and the  
25 encrypted file may be written to one portable storage medium

as separate files.

(7) The password registration unit 100 may read key information from the key storage medium 20, subject the read key information to a hash algorithm to generate first authentication information, and write the generated first authentication information in association with the encrypted key, to the storage unit 400. In this case, the file decryption unit 300 may read the encrypted key and the first authentication information from the storage unit 400, decrypt the encrypted key to generate key information, and subject the generated key information to the hash algorithm that was used in the above encryption, to generate second authentication information. Following this, the file decryption unit 300 may compare the first authentication information and the second authentication information to see if they match. If they do not match, the encrypted key is judged to have been altered, or if they match, the encrypted key is judged not to have been altered.

The file encryption unit 200 may also generate first authentication information from a file key in the same way as described above, and writes the generated first authentication information in association with the encrypted file key, to the storage unit 400. The file decryption unit 300 may read the first authentication information and the file key, generate second authentication information from

the read file key in the same way as described above, and compare the read first authentication information with the generated second authentication information, to detect an alteration of the file key if any. Also, an alteration of a plaintext can be detected in the same manner as described above.

(8) The password registration unit 100 may write the key information and the encrypted key, in association with each other, as one file to the storage unit 400.

As one example shown in Fig. 9, the file encryption unit 200 writes the encrypted key and the encrypted file key to the header part of the encrypted file 404a, and the ciphertext to the data part of the encrypted file 404a in the storage unit 400b. In this case, the file decryption unit 300 reads the encrypted key from the header part of the encrypted file 404a, instead of reading the encrypted key from the file 403 in the storage unit 400.

By storing the encrypted key to a header part of each encrypted file, a ciphertext stored therein can be decrypted only using a password if the encrypted file is transferred to another computer. It should be noted here, however, when the password is changed, the encrypted key in the header part of each concerned encrypted file needs to be updated. Also, storing the encrypted key and the key information required for encrypting a plaintext into one storage medium serves

as convenient.

(9) The file encryption unit 200 may further receive an input of a user indication, the user indication showing whether an encrypted key and a ciphertext are to be stored in association with each other into one encrypted file. When the indication shows that the encrypted key and the ciphertext are to be stored in association with each other into one encrypted file, the file encryption unit 200 writes the encrypted key to the header part of the encrypted file, and the ciphertext to the data part of the encrypted file.

It should be noted here that an encrypted file that does not store an encrypted key cannot be decrypted only with a password unless the encrypted key is stored separately.

(10) The password registration unit 100 may write the generated encrypted key to the key storage medium 20 instead of to the storage unit 400.

## 2. Second Embodiment

The following is an explanation of a file management apparatus 10b relating to a second embodiment of the present invention.

The file management apparatus 10b is a computer system on which the key storage medium 20 is loaded, as the file management apparatus 10.

2.1 Constructions of the File Management Apparatus 10b and the Key Storage Medium 20

The following is an explanation of the constructions of the file management apparatus 10b and the key storage medium 20.

The file management apparatus 10b includes a password registration unit 100b, a file encryption unit 200b, a file decryption unit 300b, and a storage unit 400b, and the key storage medium 20 is connected to the file management apparatus 10b as shown in Fig. 10.

The password registration unit 100b includes a password input unit 101b and an encryption unit 102b. The file encryption unit 200b includes a file key generation unit 201b, an encryption unit 202b, an encryption unit 203b, an encryption unit 204b, and a decryption unit 205b. The file decryption unit 300b includes a password input unit 301b, a decryption unit 302b, a switch unit 303b, a decryption unit 304b, and a decryption unit 305b. The following explanation focuses on the differences from the construction of the file management apparatus 10.

#### (1) Storage Unit 400b

The storage unit 400b, as the storage unit 400, stores a plaintext file 401b beforehand, the plaintext file 401b storing a plaintext.

#### (2) Password Input Unit 101b

The password input unit 101b, as the password input unit 101, receives an input of a password, and outputs the received

password to the encryption unit 102b.

### (3) Encryption Unit 102b

The encryption unit 102b, as the encryption unit 102, reads key information from the key storage medium 20, subjects  
5 the password received from the password input unit 101b to the encryption algorithm E1 using the read key information to generate an encrypted password, and writes the generated encrypted password as a file, to the storage unit 400b.

### (4) File Key Generation Unit 201b

10 The file key generation unit 201b, as the file key generation unit 201, generates a file key, and outputs the generated file key to the encryption unit 202b, the encryption unit 203b, and the encryption unit 204b.

### (5) Decryption Unit 205b

15 The decryption unit 205b reads the encrypted password stored in the storage unit 400b, and reads the key information from the key storage medium 20. The decryption unit 205b then subjects the read encrypted password to the decryption algorithm D1 using the read key information to generate a  
20 password, and outputs the generated password to the encryption unit 202b.

### (6) Encryption Unit 203b

The encryption unit 203b, as the encryption unit 203, reads the plaintext file 401b from the storage unit 400b,  
25 and receives the file key from the file key generation unit

201b.

The encryption unit 203b then subjects a plaintext included in the plaintext file 401b to the encryption algorithm E3 using the received file key as a key to generate a ciphertext, and writes an encrypted file 404b including the generated ciphertext in the data part thereof, to the storage unit 400.

#### (7) Encryption Unit 202b

The encryption unit 202b receives the password from the decryption unit 205b and the file key from the file key generation unit 201b. The encryption unit 202b then subjects the received file key to the encryption algorithm E2 using the received password as a key to generate a first encrypted file key, and writes the generated first encrypted file key to the header part of the encrypted file 404b in the storage unit 400b.

#### (8) Encryption Unit 204b

The encryption unit 204b reads the key information from the key storage medium 20, receives the file key from the file key generation unit 201b. The encryption unit 204b then subjects the file key to the encryption algorithm E4 using the read key information as a key to generate a second encrypted file key, and writes the generated second encrypted file key to the header part of the encrypted file 404b in the storage unit 400b. It should be noted here that the encryption algorithm E4 complies with DES.

(9) Switch Unit 303b

The switch unit 303b receives an input of either a first type or a second type from the user. The first type indicates to decrypt a ciphertext using a password, and the second type  
5 indicates to decrypt a ciphertext using key information.

When the input of the first type is received, the switch unit 303b receives the file key from the decryption unit 302b, and outputs the received file key to the decryption unit 305b. When the input of the second type is received, the switch  
10 unit 303b receives the file key from the decryption unit 304b, and outputs the received file key to the decryption unit 305b.

(10) Password Input Unit 301b

The password input unit 301b, as the password input unit 101, receives an input of a password from the user, and outputs  
15 the received password to the decryption unit 302b.

(11) Decryption Unit 302b

The decryption unit 302b receives the password from the password input unit 301b, reads the first encrypted file key included in the header part of the encrypted file 404b in  
20 the storage unit 400b. The decryption unit 302b then subjects the read first encrypted file key to the decryption algorithm D2 using the read password as a key to generate a file key, and outputs the generated file key to the switch unit 303b.

(12) Decryption Unit 304b

25 The decryption unit 304b reads the key information from

the key storage medium 20, reads the second encrypted file key included in the header part of the encrypted file 404 in the storage unit 400b, and subjects the read second encrypted file key to the decryption algorithm D4 using the read key information as a key to generate a file key. Here, the decryption algorithm D4 complies with DES, and is to perform the inverse conversion to the encryption algorithm E4.

The decryption unit 304b outputs the generated file key to the switch unit 303b.

#### 10 (13) Decryption Unit 305b

The decryption unit 305b receives the file key from the decryption unit 304b, reads a ciphertext included in the data part of the encrypted file 404b in the storage unit 400, and subjects the read ciphertext to the decryption algorithm D3 using the received file key as a key to generate a decrypted text. The decryption unit 305b writes a decrypted text file 402b including the generated decrypted text to the storage unit 400.

### 2.2 Operation of the File Management Apparatus 100b

20 The following is an explanation of the operation of the file management apparatus 10b.

#### (1) Operation of the Password Registration Unit 100b

The following is an explanation of the operation of the password registration unit 100b, with reference to a flowchart shown in Fig. 11.

The password input unit 101b receives an input of a password from the user, and outputs the received password to the encryption unit 102b (step S201).

The encryption unit 102b then reads key information from the storage area of the key storage medium 20 (step S202), subjects the password to the encryption algorithm E1 using the key information as a key to generate an encrypted password (step S203), and writes the generated encrypted password as a file, to the storage unit 400b (step S204).

## 10 (2) Operation of the File Encryption Unit 200b

The following is an explanation of the operation of the file encryption unit 200b, with reference to a flowchart shown in Fig. 12.

The decryption unit 205b reads an encrypted password stored in the storage unit 400b, reads key information from the key storage medium 20, subjects the read encrypted password to the decryption algorithm D1 using the read key information to generate a password, and writes the generated password to the encryption unit 202b (step S221).

20 Following this, the file key generation unit 201b generates a file key (step S222).

The encryption unit 203b then reads the plaintext file 401b from the storage unit 400b, subjects a plaintext included in the plaintext file 401b to the encryption algorithm E3 using the file key as a key to generate a ciphertext (step

S223), and writes the encrypted file 404b including the generated ciphertext in the data part thereof, to the storage unit 400b (step S224).

Following this, the encryption unit 202b receives the password and the file key, and subjects the file key to the encryption algorithm E2 using the password as a key to generate a first encrypted file key (step S225), and writes the generated first encrypted file key to the header part of the encrypted file 404b in the storage unit 400b (step S226).

Following this, the encryption unit 204b receives the file key and the key information, subjects the file key to the encryption algorithm E4 using the key information as a key to generate a second encrypted file key (step S227), and writes the generated second encrypted file key to the header part of the encrypted file 404b in the storage unit 400b (step S228).

### (3) Operation of the File Decryption Unit 300b

The following is an explanation of the operation of the file decryption unit 300b, with reference to a flowchart shown in Fig. 13.

The switch unit 303b receives an input of either the first type or the second type from the user (step S241).

When the switch unit 303b receives the input of the first type (step S242), the password input unit 301b receives an input of a password from the user and outputs the received

password to the decryption unit 302b (step S245). The decryption unit 302b reads a first encrypted file key from the storage unit 400b, subjects the read first encrypted file key to the decryption algorithm D2 using the password as a key to generate a file key, and outputs the generated file key to the decryption unit 305b via the switch unit 303b (step S246).

When the switch unit 303b receives the input of the second type (step S242), the decryption unit 304b reads key information from the key storage medium 20 (step S243), reads a second encrypted file key from the storage unit 400b, subjects the read second encrypted file key to the decryption algorithm D4 using the key information as a key to generate a file key, and outputs the file key to the decryption unit 305b via the switch unit 303b (step S244).

Following this, the decryption unit 305b reads a ciphertext included in the data part of the encrypted file 404b in the storage unit 400b, and subjects the read ciphertext to the decryption algorithm D3 using the file key as a key to generate a decrypted text (step S247), and writes a decrypted text file 402b including the generated decrypted text, to the storage unit 400b (step S248).

### 2.3 Conclusions

The file management apparatus 10b has the three functions : password registration; plaintext encryption; and

ciphertext decryption.

For registering a password, the user loads the key storage medium storing key information beforehand, on the file management apparatus 10b, and inputs a password to be registered. The password registration unit 100b encrypts the input password using the key information, and stores the generated encrypted password in the computer system. In the second embodiment, information to be encrypted and a key used in the encryption are reversed as compared with those in the first embodiment.

For encrypting a plaintext, the user first loads the key storage medium on the computer system in which the encrypted password is present, and designates a file to be encrypted. The file encryption unit 200b first decrypts the encrypted password using the key information so as to obtain a password. Following this, the file encryption unit 200b encrypts a generated file key using the password, to generate a first encrypted file key. Also, the file encryption unit 200b encrypts the file key using the key information to generate a second encrypted file key. The file encryption unit 200b then encrypts information stored in the file using the file key to generate a ciphertext, and writes an encrypted file including the first encrypted file key and the second encrypted file key in the header part thereof, and the ciphertext in the data part thereof, to the storage unit 400b.

For decrypting a ciphertext, there are two methods, one using key information and the other using a password. When using key information, the file decryption unit 300b decrypts the second encrypted file key acquired from the header part of the encrypted file 404b using the key information, to obtain a file key. The file decryption unit 300b then decrypts the ciphertext using the obtained file key as a key. When using a password, the file decryption unit 300b receives an input of the password from the user, decrypts the first encrypted file key using the received password to obtain a file key, and decrypts the ciphertext using the file key as a key to obtain the original plaintext.

## 2.4 Modification

Although the present invention has been described based on the second embodiment, the invention should not be limited to such. For instance, the file management apparatus 10b may be constructed according to the following modifications.

(1) The password registration unit 100b may further receive an input of a user ID that identifies the user, and store the encrypted password in association with the user ID, in a specific computer system. In this case, the file decryption unit 200b receives an input of a user ID, and then decrypts an encrypted password that is associated with the input user ID.

(2) The following is an explanation of the operation

of the file management apparatus 10b when a password is changed,  
with reference to a flowchart shown in Fig. 14.

The password registration unit 100b reads key  
information from the key storage medium 20, reads a second  
5 encrypted file key from the encrypted file 404b, and subjects  
the second encrypted file key to the decryption algorithm  
D4 using the key information as a key to generate a file key  
(step S261). Following this, the password registration unit  
100b receives an input of a new password from the user (step  
10 S262), subjects the generated file key to the encryption  
algorithm E2 using the new password as a key to generate a  
new first encrypted file key (step S263), and updates the  
first encrypted file key in the encrypted file 404b to the  
new first encrypted file key (step S264).

15 (3) For preventing encrypted information from being  
decrypted using a password, the file management apparatus  
10b deletes the first encrypted file key in the encrypted  
file 404b. In this case, decryption using key information  
is available.

20 (4) The following is an explanation of the operation  
of the file management apparatus 10b when key information  
is updated, with reference to a flowchart shown in Fig. 15.

The key storage medium stores new key information  
beforehand, instead of the key information employed previously  
25 (referred to as old key information).

The file encryption unit 200b receives an input of a password that is the same as the password received previously (step S281), reads a first encrypted file key from the encrypted file 404b (step S282), and subjects the first encrypted file key to the decryption algorithm D2 using the received password as a key to generate a file key (step S283). Following this, the file encryption unit 200b reads the new key information from the key storage medium, subjects the file key to the encryption algorithm E4 using the new key information as a key to generate a new second encrypted file key (step S284), and updates the second encrypted file key in the encrypted file 404b to the new second encrypted file key (step S285).

(5) In the above embodiment, the encrypted password is stored in a computer system in which a plaintext has been encrypted to generate a ciphertext, and so decryption of the ciphertext using a password is made only possible within the computer system. To enable the decryption of the ciphertext using the password in another computer system, the encrypted key may be stored in a portable storage medium, and inputted into the other computer system.

Here, the password registration unit 100b in the computer system writes the encrypted password to a portable storage medium such as a SD memory card. Also, the user writes the encrypted file to another portable storage medium. The user then loads the portable storage medium to which the encrypted

key has been written, and the portable storage medium to which the encrypted file has been written, on the other computer system, so that a file decryption unit in the other computer system reads the encrypted key from the portable storage medium, 5 decrypts the read encrypted key, and also, reads the encrypted file from the portable storage medium, and decrypts the read encrypted file.

It should be noted here that the encrypted key and the encrypted file may be written to one portable storage medium 10 as separate files.

(6) When encrypting a plaintext to generate a ciphertext, the file encryption unit 200b may add various information to the header part of the encrypted file, the various information including encryption information indicating that 15 the plaintext has been encrypted, and a user ID for the key information. In this case, when key information or a password is updated, the file encryption unit 200b may retrieve the encrypted file with reference to the additional information, such as encryption information indicating that the plaintext 20 has been encrypted and a user ID for the key information, in procedures described in the items (2) or (4). Instead of writing such additional information to the header part of each encrypted file, the file encryption unit 200b may write such additional information for each encrypted file, to one 25 unified file. In this case, the file encryption unit 200b

retrieves each concerned encrypted file from the unified file in procedures described in the items (2) or (4).

(7) When encrypting a plaintext to generate a ciphertext, the file encryption unit 200b may further receive an input of a user indication, and determine whether to store a first encrypted file key into the header part of the encrypted file, according to the content of the user indication. When the first encrypted file key is determined to be stored, it is stored in the header part of the encrypted file as described above. When the first encrypted file key is determined not to be stored, neither generation nor storing of the first encrypted file key is performed. When the first encrypted file key is stored in the encrypted file, the ciphertext can be decrypted using a password. When the first encrypted file key is not stored in the encrypted file, the ciphertext is prohibited from being decrypted using a password.

(8) For prohibiting a ciphertext from being decrypted using key information in a case where the user loses the key information, the file management apparatus 10b deletes a second encrypted file key. This can prevent unauthorized users from decrypting encrypted information by acquiring the lost key information. In this way, the key information can be made temporarily invalid in the second embodiment, which is impossible in the first embodiment. In this case, decryption using a password is available.

Furthermore, according to the construction described in the item (4), the encrypted information can be decrypted using a password. Therefore, the user is allowed to have access to encrypted files without any inconvenience until  
5 new key information is issued. Also, when the new key information is issued, the only thing to do is to update the header part of each concerned encrypted file, so that decryption of each encrypted file using the new key information thereafter becomes possible.

10 The following is an explanation of operations when the user loses the key storage medium, with reference to flowcharts shown in Figs. 16 to 18.

As shown in these flowcharts, key information is made temporarily invalid when the user loses the key storage medium  
15 (step S301). When the user intends to decrypt a ciphertext while the key information is being invalid, a decryption process using a password is performed (step S302).

Next, new key information is issued. When the user is provided with a key storage medium storing the new key  
20 information, a new second encrypted file key is generated (step S303), and a normal decryption process is performed using the new key information (step S304).

The following explains detailed processes performed in steps S301 to S304.

25 In the process for making the key information temporarily

invalid in Step S301, the file management apparatus 10b deletes the second encrypted file key (step S311).

In the decryption process using a password in step S302, the password input unit 301b receives an input of a password from the user (step S321), the decryption unit 302b reads the first encrypted file key from the storage unit 400b, subjects the read first encrypted file key to the decryption algorithm D2 using the password as a key to generate a file key, and outputs the generated file key to the decryption unit 305b via the switch unit 303b (step S322). Following this, the decryption unit 305b reads a ciphertext included in the data part of the encrypted file 404b in the storage unit 400b, and subjects the read ciphertext to the decryption algorithm D3 using the file key as a key to generate a decrypted text (step S323). The decryption unit 305b then writes the decrypted text file 402b including the generated decrypted text to the storage unit 400b (step S324).

In the new second encrypted file key generation process in step S303, the file encryption unit 200b receives an input of a password that is the same as the password received previously (step S331), reads the first encrypted file key from the encrypted file 404b (step S332), and subjects the first encrypted file key to the decryption algorithm D2 using the password as a key to generate a file key (step S333). Following this, the file encryption unit 200b reads new key

information from the key storage medium, subjects the file key to the encryption algorithm E4 using the new key information as a key to generate a new second encrypted file key (step S334), and updates the second encrypted file key in the encrypted file 404b to the generated new second encrypted file key (step S335).

In the normal decryption process using the new key information in step S304, the decryption unit 304b reads the new key information from the key storage medium (step S341) and the new second encrypted file key from the storage unit 400b, subjects the read new second encrypted file key to the decryption algorithm D4 using the new key information as a key to generate a file key, and outputs the generated file key to the decryption unit 305b via the switch unit 303b (step S342). Following this, the decryption unit 305b reads a ciphertext included in the data part of the encrypted file 404b in the storage unit 400b, subjects the read ciphertext to the decryption algorithm D3 using the file key as a key to generate a decrypted text (step S343), and writes the decrypted text file 402b including the generated decrypted text to the storage unit 400b (step S344).

(9) The file decryption unit 300b may require both key information and a password for decrypting a ciphertext.

Also, a first encrypted file key and a second encrypted file key each may be decrypted using both a password and key

information, to generate two file keys, and an alteration in the header part of the encrypted file may be detected by judging whether the generated two file keys match or not.

(10) As in the first embodiment, authentication information may be added to an encrypted password, a first encrypted file key, a second encrypted file key, and a ciphertext, so that the authentication information can be utilized for detecting an alteration of each of the encrypted password, the first encrypted file key, the second encrypted file key, and the ciphertext.

### 3. Conclusions

According to the present invention as described above, encryption and decryption of a file using key information accompanying a computer becomes possible. In addition, decryption of the file only using a password that has been registered beforehand and stored securely in the computer is possible if indicated at the time of the encryption. The password does not need to be set each time a file is encrypted. Also, the present invention provides structures for making decryption using a password temporarily invalid, or easily changing the password, in case the user forgets the password. Also, the present invention further provides structures for making key information temporarily invalid in case the user loses the key information. When new key information is issued, a file that has encrypted with the lost key information can

be decrypted using the new key information merely by updating the header part of the encrypted file. Also, by storing an ID for key information or for a password in a header part of each encrypted file or in a unified management file, each encrypted file that requires a change in accordance with updating key information or a password can be retrieved.

As described above, the present invention provides a file encryption/decryption system that satisfies the following conditions.

(1) Encryption of a file is performed using key information stored in a storage medium such as an IC card. Once a password is registered beforehand, it is not necessary to input a password every time encryption is performed.

(2) Decryption of a file is normally performed using the key information. Also, the decryption of the file using the password registered beforehand is made possible by a user indication at the time when the file is encrypted.

(3) The system comprises a structure allowing a password to be changed easily.

(4) The system comprises a structure that makes key information temporarily invalid when the key information is lost, a structure allowing, when new key information is issued, an encrypted file that has been encrypted using the key information, to be handled with the new key information, and a structure that easily retrieves an encrypted file to be

changed due to the change of the key information.

#### 4. Other Modifications

Although the present invention has been described based on the above embodiments, the invention should not be limited to such. For example, the following modifications are possible.

(1) In the above embodiments, DES is employed as the decryption/encryption algorithm. However, other decryption/encryption algorithms may instead be employed.

10 (2) The present invention also applies to the method used by the apparatuses described above. This method may be realized by computer programs that are executed by computers. Such computer programs may be distributed as digital signals.

Also, the present invention may be realized by a  
15 computer-readable storage medium, such as a floppy disk, a hard disk, a CD-ROM (Compact Disc-Read Only Memory), an MO (Magneto-Optical) disc, a DVD (Digital Versatile Disc), a DVD-ROM, a DVD-RAM, or a semiconductor memory, on which computer programs and/or digital signals mentioned above are  
20 recorded. Conversely, the present invention may also be realized by a computer program and/or digital signal that is recorded on a storage medium.

Computer program or digital signals that achieve the present invention may also be transmitted via a network, such  
25 as an electric communication network, a wired or wireless

communication network, or the Internet.

Also, the above embodiments of the present invention can be realized by a computer system that includes a microprocessor and a memory. In this case, a computer program  
5 can be stored in the memory, with the microprocessor operating in accordance with the computer program.

The computer programs and/or digital signals may be provided on an independent computer system by distributing a storage medium on which the computer programs and/or digital  
10 signals are recorded, or by transmitting the computer programs and/or digital signals via a network. The independent computer may then execute the computer programs and/or digital signals to function as the present invention.

(3) The limitations described in the embodiment and the  
15 modifications may be freely combined.

Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modifications will  
20 be apparent to those skilled in the art. Therefore, unless such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.